

PATENT SPECIFICATION

(11) 1 276 731

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DRAWINGS ATTACHED

- (21) Application No. 29411/69 (22) Filed 10 June 1969
- (31) Convention Application Nos.
P 17 71 643.7 (32) Filed 20 June 1968
P 19 12 774.3 13 March 1969 in
- (33) Germany (DT)
- (45) Complete Specification published 7 June 1972
- (51) International Classification B29F 1/00
B29C 1/00
- (52) Index at acceptance
B5A 1R11 1R20 1R51 1R73 2E6 2E8 3D4X 3DX



(54) A MOULD FOR AND PROCESS OF FORMING CERAMIC PRODUCTS

(71) We, C. M. HUTSCHENREUTHER
ZAHNFABRIK ZWEIGNIEDERLASSUNG DER C.
M. HUTSCHENREUTHER PORZELAN AG, a
German body corporate registered under
5 German Law of Arzberg, Bavaria, Ger-
many, do hereby declare the invention for
which we pray that a Patent may be granted
to us, and the method by which it is to be
performed, to be particularly described in
10 and by the following statement:—

This invention relates to a mould for and
a process of forming ceramic products.

The forming of shaped ceramic parts has
hitherto usually been effected by pressing,
15 throwing or casting. In these methods
plaster moulds are almost exclusively used.

The effectiveness of these moulds depends
upon the porosity of the plaster when his
has set.

20 One defect of modern mass production
methods is that because of their poor mech-
anical properties and the solubility of plaster
in water the moulds have only a fairly short
life. Another drawback is that dewatering
25 of the shaped ceramic parts which proceeds
in or on the moulds involves a considerable
expenditure in moulds and machines be-
cause of the poor resistance of plaster to
heat.

30 Many attempts have therefore already
been made to overcome these defects by
improving the mechanical and thermal prop-
erties of the plaster used for making the
moulds.

35 Additions of cellulose derivatives, poly-
vinyl alcohols and acetates, lime and cement
as well as of synthetic plastics materials
based on epoxy, polyester and methacrylate
resins have been proposed. However, since
40 these additions for improving mechanical
properties of the plaster also adversely affect
its porosity, they have not been a success in
actual practice.

It has also been proposed to make moulds
45 for forming ceramic parts from materials

other than plaster.

For example, German Patent Specification
("patentschrift") No. 1 127 787 describes a
material for the production of moulds which
consists of a highly fired ceramic mass rich 50
in clay products and containing some fluxes,
and the published specification of German
("auslegesschrift") No. 1 241 751 relates to
a method of producing moulds based on in-
organic filler materials in association with 55
organic binders. However, even these
methods have not proved successful in prac-
tice because the firing process leads to
shrinkage and more particularly to distor-
tion of the moulds and the above-men- 60
tioned specification comments on the con-
siderable difficulties encountered in the de-
velopment of the necessary pore system.

It is a primary object of the present in-
vention to overcome the defects of the 65
hitherto practised methods of forming plastic
ceramic masses by forming the plastic cera-
mic mass in an injection moulding process
and dewatering the mass through a porous 70
wall structure of the mould. The essence of
the invention resides in using an injection
moulding technique in conjunction with
moulds of satisfactory porosity. Preferably
the moulds are also heat-resisting.

It is preferred to make these moulds from 75
inorganic filler materials in a binder formed
from synthetic resins of a particular group.
Filler materials suitable for the purpose of
the invention are any substances which con-
duct heat, and which can be prepared in 80
grain sizes between 0.005 and 0.5 mm. In
practice metal powders, such as powdered
aluminium and/or copper are used.

The binders for producing a mould ac-
cording to the invention are any synthetic 85
resins which evolve a gaseous phase at the
temperature of setting. In practice it is pre-
ferred to employ polycondensation resins,
such as phenolic, melamine and urea resins.

The capillary system which is essential to 90

the effectiveness of the moulds must have continuous open-ended pores traversing the thickness of the material and formed by the evolution of the gaseous substances during 5 the process of setting of the resin.

It has proved advantageous to include in the compositions employed for making the moulds according to the invention a proportion of the above specified synthetic resin 10 binders between 5 and 35%. The binders should be in a liquid or pulverulent form or in a mixture of both. The binders may be hot or cold setting with or without the application of pressure.

15 The mass production of ceramic mouldings by injection moulding in porous heatable moulds has the advantage that the ceramic mouldings can be very quickly de-watered.

20 On the one hand a stationary upper part of a mould may be adapted to co-operate with a plurality of heated bottom parts of moulds on an indexable table to close each of the bottom parts only during the process 25 of injection, so that after the mouldings have been formed they can be de-watered to leather hardness within 60 seconds by heating the bottom mould halves and additionally admitting hot air, preferably from 30 above.

Alternatively the injection moulded parts may be de-watered by suitably increasing the pressure directly above the developed pore system of the mould, the build-up of pressure 35 sure being effected by the pressure generating means of the injection moulding machine transmitted by way of the injection moulded mass itself.

Additional heating of the moulds in this 40 procedure results in the ceramic mouldings being ready for ejection from the moulds in a leather hard state after as short a time as a few seconds.

For large scale production the first mentioned method of drying requires an upper mould part as well as up to 15 bottom mould halves, whereas the second method of de-watering permits the production of ceramic mouldings to proceed in a single working mould. In both methods simple plunger type machines are entirely suitable for the injection moulding process and the plastic ceramic mass may be injected cold, i.e., at room temperature. In the ceramic industries 50 this technique, which is the first to propose the use of heated moulds for de-watering ceramic mouldings, constitutes a very substantial step forward in the art. Compared with conventional forming methods the 55 number of moulds required is considerably less, bearing in mind that at present it is usual to use 1500 to 3000 moulds in a set. Additional economies arise in connection with the replacement of moulds as well as in 60 the handling, transportation and storage of 65

moulds.

By producing ceramic parts by injection moulding the drying devices hitherto required for drying to leather hardness as well as the hitherto necessary dressing and cleaning off are eliminated. 70

Moreover, the consumption of ceramic mass is reduced by as much as 40% compared with modern throwing techniques, 75 since forming by injection moulding eliminates the necessary excess of plastic mass required for throwing. An important advantage of the injection moulding technique resides in that it also permits parts to be produced that cannot be thrown or jiggered 80 and that hitherto had to be cast.

In another development of the proposed method of producing shaped ceramic parts, it is proposed not only to use heated moulds but in addition also to heat the plastic mass 85 itself prior to moulding. It has been found that it is useful to heat the moulding mass to between 40 and 140°C, preferably to between 70 and 95°C, before it is injected 90 into the mould.

According to one important embodiment of the invention the plastic ceramic mass is moulded in an injection moulding machine of the screw press type and the moulding mass is at least partly preheated in the 95 machine.

The advantages that can thus be achieved are very significant. These already arise in the preparation of the plastic mass. Whereas hitherto special machines had to be provided for homogenising and de-aerating the mass in a separate operation, the mass as obtained from the filter press or from the kneading operation can be directly processed by the method according to the invention. 100 Moreover, the hitherto necessary and very costly preparation of the masses in a vacuum press can also be dispensed with. 105

According to the invention—and this is yet another major advantage—the water content of the plastic masses that are to be moulded can be kept substantially lower than in hitherto conventional processing methods because the steam cushion which forms when the water-plasticised injection 110 moulding mass is heated ensures a fully satisfactory degree of flowability for forming, even when the water content of the mass is only about 15%. Hence the mass used for injection moulding according to the invention is processed with a water content between 10 and 20 percent by weight and preferably between 14 and 18 percent by 115 weight.

The proposal to use moulding masses that are heated prior to moulding may be performed, as above-mentioned, by heating the mass in a screw injection press. In such a 120 press a considerable proportion of the required thermal energy can be provided by 125

the heat of friction generated during plasticification.

Another very important advantage of the invention is that dewatering of the ceramic shaped products is much more rapid. Dewatering already commences during the actual moulding process since the steam contained in the preheated injected mass can escape through the pores of the mould. Consequently the mouldings can be taken out of the mould in a leather hard state directly after they have been moulded.

Another significant advantage of the invention is that for producing ceramic mouldings from plastic ceramic masses by the injection moulding technique only a single working mould is required.

A further advantage that should not be underestimated is that, in this method, densification of the mass in the mould is much higher, with a consequent improvement in quality.

Vacuum de-aeration prior to injection, of the plastic ceramic mass, is not essential. Besides the advantages that have already been mentioned, the invention also has the advantage of permitting complicated ceramic shapes to be produced in a single operation. This applies more particularly, though not exclusively, to the production of cups. In the production of cups the proposed method eliminates the necessity of producing the body of the cup and the handle in separate operations. A cup formed with a handle can be produced in one operation.

The invention is illustrated by way of example in the drawing, in which:—

Fig. 1a is a sectional elevation of a closed injection mould, and

Fig. 1b is a diagrammatic view illustrating the drying of the injection moulded part, and

Fig. 2 is a sectional elevation showing another method of drying the moulding.

Referring to the drawing, a ceramic moulding 1 is shown inside a mould consisting of a porous bottom part 2, an upper part 3 and a sprue 5 for injecting the mass. Both the upper part 3 and the lower part 2 of the mould contain heating elements 4 and 4'. As shown in Fig. 1b, when injection has been completed the upper part of the mould 3 which serves to close a plurality of lower parts 2—all the lower parts 2 being supported, for example, on an indexable table—is removed and the lower part 2 containing the moulding 1 is taken to a drying device 6 for drying the moulding, in which hot air is blown on the moulding from nozzles (see the arrows). The moulding is thus dried to leather hardness in a very short period of time.

In Fig. 2 the moulding 1 is dried by the application of pressure which forces the moisture through the pores in the bottom

part 2 of the mould. The pressure may be transmitted by the mass itself through the sprue 5. The discharged moisture collects in a channel 7 through which it is withdrawn.

A mould as described above, suitable for use in the process according to the invention may be formed by moulding from a composition having the following constituents:—

400 gm of copper grain size 100-120/u 75

2250 gm of aluminium powder 40- 60/u

270 gm of a liquid phenolic resol

360 gm of a solid phenolic resin based 1276731—GALLEY TWO

on novolac hexamethylene tetramine in powder form.

After mixing together the constituents of the composition, it is moulded in a hydraulic press and is set by subjecting it to heat. 85

WHAT WE CLAIM IS:—

1. An injection mould for the production of a moulded dewatered ceramic mass, at least part of said mould being formed of a heat-conducting material, comprising an inorganic metal filler material bound in a synthetic resin and having a porous structure comprising a capillary system produced by means of a gaseous phase evolved by the resin during setting thereof. 90

2. An injection mould as claimed in Claim 1, in which the heat conducting inorganic metal filler comprises a powder having a grain size of from 0.005 mm to 0.5 mm. 100

3. An injection mould as claimed in Claim 2, in which the metal powder is copper and/or aluminium.

4. An injection mould as claimed in any one of Claims 1 to 3, in which the synthetic resin binder comprises a polycondensation resin. 105

5. An injection mould as claimed in Claim 4, in which the synthetic resin binder includes a phenolic, melamine or urea resin. 110

6. An injection mould as claimed in any one of Claims 1 to 5, in which the proportion of resin binder in the composition forming said mould is from 5 per-cent to 35 per-cent. 115

7. An injection mould as claimed in Claim 1, substantially as described herein and as shown in the accompanying drawing.

8. A process for the production of a ceramic product wherein a plastic mass is injected into an injection mould as claimed in any preceding claim and the moulded product is dewatered through the capillaries of said mould. 120

9. A process as claimed in Claim 8, 125 wherein the moulded product is dewatered and dried to a leather hardness by heating the injection mould and additionally subjecting the moulded product to treatment with hot air. 130

10. A process as claimed in Claim 9, wherein the injection mould is opened prior to dewatering the moulded product, to expose a face of the latter whilst leaving the remainder supported in a part of the mould having a porous wall structure, and the product is dewatered by heating said porous part of the mould and blowing hot air upon the exposed face of said product.
- 10 11. A process as claimed in Claim 8, wherein the moulded product is dewatered and dried to leather hardness by heating the injection mould and subjecting the moulded product to pressure.
- 15 12. A process as claimed in Claim 11, wherein the moulded product is subjected to pressure by way of the plastic ceramic mass in the sprue of the mould.
13. A process as claimed in any one of 20 Claims 8 to 12, wherein the plastic ceramic mass is preheated prior to injection into the mould.
14. A process as claimed in Claim 13, wherein the plastic ceramic mass is pre-heated to a temperature of from 40°C to 25 140°C.
15. A process as claimed in Claim 14, wherein the plastic ceramic mass is pre-
- heated to a temperature of from 70°C to 95°C.
16. A process as claimed in any one of Claims 13 to 15, wherein the plastic ceramic mass is injected into the mould by means of a screw press serving to effect at least partial preheating of the mass due to heat generated by friction.
17. A process as claimed in any one of Claims 8 to 16, wherein the plastic ceramic mass injected into the mould has a water content of from 10 per-cent to 20 per-cent by weight.
18. A process as claimed in Claim 17, wherein the plastic ceramic mass injected into the mould has a water content of from 14 per-cent to 18 per-cent by weight.
19. A process as claimed in any one of Claims 8 to 18, wherein the plastic ceramic mass is injected into the mould without prior vacuum de-aeration.
20. A process as claimed in Claim 10, substantially as described herein.

GEE AND CO.,
Chartered Patent Agents,
51-52 Chancery Lane,
London, WC2A 1HL.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1972.
Published at the Patent Office, 25 Southampton Buildings, London WC2A 1AY from which copies
may be obtained.

1276731 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of
the Original on a reduced scale.*

Fig. 1a

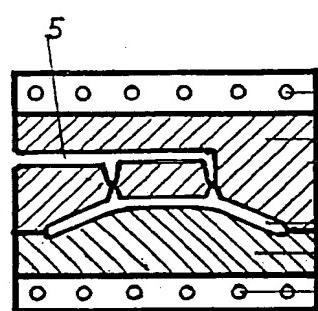


Fig. 1b

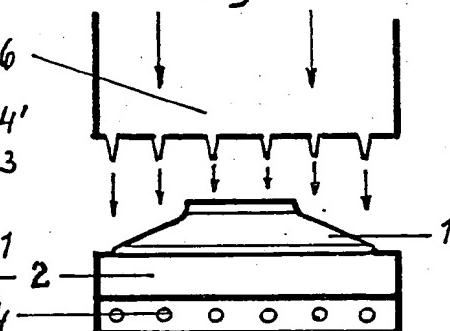
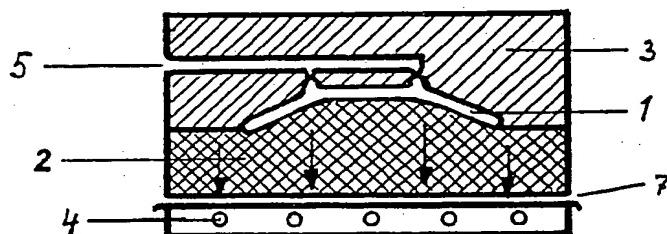


Fig. 2



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